Agricultural Biotechnology and Sustainable Development

MARK WINFIELD
Director of Research
Canadian Institute for Environmental Law and Policy
Toronto, Ontario, Canada

The Canadian Institute for Environmental Law and Policy (CIELAP) was founded in 1970 as the Canadian Environmental Law Research Foundation. It is an independent, not-for profit, environmental law and policy research and education organization. Over the last 15 years, CIELAP has been involved extensively in environmental law and policy development related to biotechnology. In 1984, CIELAP organized the first conference in Canada on environmental law and policy issues regarding biotechnology, and it has participated in many consultations regarding biotechnology and the environment with Environment Canada, Health Canada, Agriculture and Agri-Food Canada, and the government of Ontario.

The Institute has produced major publications regarding biotechnology, including a major overview study in 1995 of environmental, social, economic, and ethical issues related to biotechnology completed for the Ontario Ministry of Economic Development and Trade. The institute has also published a Citizen's Guide to Biotechnology, which has been well-received by a wide range of audiences.

INTRODUCTION

The biotechnology industry and some governments, particularly those of Canada and the United States, argue that the development of agricultural biotechnology products is essential to meeting the food needs of a growing world population. Indeed, they often contend that we will face a serious crisis if these technologies are not widely adopted, permitting the more efficient production of food.

This perspective on the importance of agricultural biotechnology has been disputed from several directions. Environmental and consumers' organizations, members of the farm and academic communities, and several governments in the developing world have been at the forefront of this challenge. Serious ethical concerns have been articulated in relation to many of the products that have been developed, especially in the area of animal husbandry. In addition, questions have been raised regarding the likely environmental and human health impacts of agricultural biotechnology products and, perhaps most significant, regarding the value and the purpose of many of the applications of the technology which are emerging.

In particular, it is argued that the many of the applications of agricultural biotechnology that have been developed to date are unsupportive of environmentally sustainable agriculture. In fact, it is contended that in some cases, they will actually undermine more ecologically sound agricultural practices. Furthermore, it is argued that the proponents of the global diffusion of agricultural biotechnology as a solution to the question of securing the world's food supply are proposing a technological solution to a problem that is fundamentally social, economic, and political, rather than technological, in nature.

This paper seeks to provide an overview of these critiques and of their implications for public policy in Canada and the United States regarding biotechnology in general, and agricultural biotechnology in particular.

Concerns Regarding Biotechnology and the Environment

The critique of the current trends in modern biotechnology is principally grounded on three elements. The first relates to the ethical and philosophical issues raised by modern biotechnology, particularly genetic engineering. The second arises from the potential direct environmental and human health impacts of applications of the technology. The third challenges the value and purpose of many of the applications of the technology that have emerged, particularly in the agricultural field.

Ethical/Philosophical Concerns

Public concerns regarding biotechnology arise from many sources. At the most fundamental level, many individuals are disturbed by the notion of manipulation of the genetic material of other species, and particularly the movement of genetic material between species. They regard genetic engineering as a qualitatively different technology from traditional plant breeding or animal husbandry techniques.

Many hold the species barrier to be a law of God or of nature, believing that species have an inherent integrity and that the violation of this status is an act of extreme arrogance on the part of human beings. Others question, in light of

past experiences with eugenics programs and other efforts to “improve” humanity, whether human beings have the wisdom to make appropriate decisions with respect to a technology of this scope and power. Questions of this nature were recently highlighted in the debates that followed the announcement of the successful cloning of a sheep named “Dolly” in the spring of 1997.

In Canada and the United States these concerns have been compounded by has been the absolute refusal, until very recently, of governments to address the ethical and social issues raised by biotechnology. At the same time, governments have continued to provide heavy subsidies for the development of the technology. This behavior has been in sharp contrast to the approach taken by a number of Western European governments, which have facilitated societal debates around these issues and demonstrated a willingness to act on the results of such discussions.

The government of Canada formally acknowledged the significance of ethical and social issues related to biotechnology in its April 1997 response to a report of the House of Commons Standing Committee on the Environment and Sustainable Development on the Regulation of Biotechnology in Canada. The Standing Committee's recommendations had emphasized the need to deal with the ethical issues raised by modern biotechnology. The government's response also included a commitment to the establishment of an independent advisory commission to examine the societal and ethical issues raised by biotechnology. However, the membership, form, and structure of the commission have yet to be established.

Direct Environmental and Health Effects

The second source of concern regarding agricultural biotechnology products relates to their potential direct effects on environmental and human health. A report recently prepared for the Organization for Economic Cooperation and Development (OECD) ranked the environmental impacts of the commercialization of biotechnology as one of the ten most important new environmental issues facing the world, along with such challenges as global warming and environmental terrorism. In the late 1980s, ecologists and members of other disciplines identified a range of potential negative effects arising from the release of genetically engineered organisms into the environment. These potential impacts included

- the creation of new pests, such as the escape of a transgenic salt-tolerant rice from cultivated fields into estuaries,
- the enhancement of the effects of existing pests or creation of new pests through hybridization or gene transfer to related plants or microorganisms,

- the enhancement of the effects of existing pests as a result of the selective pressures provided by plants modified for pest resistance or intensified pesticide use arising in conjunction with the modification of plants for pesticide resistance,
- infectivity, pathogenicity, toxicity, or other harm to nontarget species, including humans,
- disruptive effects on biotic communities, resulting in the elimination of wild or desirable natural species through competition or interference,
- adverse effects on ecosystem processes and functions, such as nutrient cycling,
- incomplete degradation of hazardous chemicals by microorganisms employed in such applications as bioremediation and waste water treatment, leading to the production of even more toxic by-products.

In addition, concerns were raised regarding the more general risk of reducing biological diversity in any given ecosystem as a result of the introduction of products of biotechnology. Such risks were explicitly recognized in the 1992 United Nations Convention on Biological Diversity. At a more fundamental level, it has been pointed out that biotechnology can threaten biodiversity through its implicit drive to breed uniformity in plants and animals, and furthering and encouraging monocultures.

It is important to realize that these environmental and health risks are not limited to the introduction of genetically engineered or modified organisms. Naturally occurring organisms can behave as “exotic” species when introduced into ecosystems of which they are not native inhabitants. In addition, the introduction of a naturally occurring species into a natural habitat can have disruptive effects if the species is introduced in very high concentrations or quantities. It also has been argued that certain naturally occurring species of microorganisms that have potential to be used in bioremediation and other applications may be opportunistic human pathogens.

Methods for predicting the consequences of the deliberate introduction of new life forms into the environment are still very much under development. The state of science to assess ecological impacts continues to lag far behind development of new products of biotechnology. This has been largely a consequence of public policy decisions regarding the funding of research in universities and governments, particularly the introduction and expansion of requirements for partnerships with the private sector by university researchers. This problem has been particularly acute in Canada and has resulted in the virtual absence of any research independent of industry support on the ecological impacts of biotechnology products, particularly in the agricultural field.

What science has emerged with respect to the potential environmental impacts of the introduction of products of biotechnology appears to confirm the validity of many of the concerns which had been theorized earlier. Recent findings have included the following:

- The long-term persistence of recombinant organisms and their genetic material in the environment can be expected.
- The commercialization of genetically engineered plants will allow transgenes coding for beneficial traits to be transferred to wild or weedy populations of these plants or their close relatives.
- The emergence of resistant pest populations in response to the commercialization of pesticidal plants is likely.
- Transgenic foods may producing allergic reactions.

More broadly, there are concerns regarding the highly reductionist nature of the current approaches to the environmental assessment of the products of biotechnology. In particular, questions have been raised about the failure to place products in appropriate ecological contexts for assessment, the failure to consider the cumulative effects of commercial-scale production, and the failure to assess products as elements of the systems of which they are integral parts (e.g., herbicide-resistant crops and herbicide use). There are also concerns in Canada regarding the failure of the regulatory system to consider adequately the issue of occupational exposure to biotechnology products.

Despite the growing evidence that significant environmental problems can be expected as a result of the commercialization of agricultural biotechnology products, the government of Canada has failed to establish any significant long-term programs to monitor and assess the environmental effects of the commercialization of genetically modified crops. Nor are any records being kept regarding the extent or location of the use of such crops or the extent of the introduction of genetically modified products into the food system. These weaknesses were highlighted in the government of Canada's suspension of the registration of a variety of herbicide-tolerant canola in the spring of 1997.

Concerns over the Value and Purpose of the Emerging Applications of Biotechnology

The third and most fundamental aspect of the critique of agricultural biotechnology challenges the value and purpose of many of the applications of the technology which are emerging. Industry and government sponsors of the technology claim that it is essential to address the problem of securing an adequate food supply for a growing world population. It is argued that the technology will make agriculture more efficient and thereby allow more people to be fed with fewer resources.

This argument is open to challenge. At the most basic level, it appears to be founded on an extremely poor and highly simplified understanding of current global food supply and population issues. The challenges which humanity faces in these areas are fundamentally of a social, economic, or political nature. The absence of particular technologies is, at best, only a small part of the overall problem.

Past experience has demonstrated that efforts to address complex social, political, and economic issues of this nature through technological fixes almost invariably fail. The introduced technologies tend to deal only with the symptoms of much deeper societal problems. They do not, and indeed cannot, address their social,
economic, or political causes. If the introduction of new technologies is not dealt with in a culturally and socially appropriate manner, the result is frequently a deepening of the original problems.

In addition, many of the leading applications of agricultural biotechnology which are emerging are simply not relevant to the challenges facing the world's food supply, particularly in the developing south. This is made particularly clear by an examination of the two leading applications of the technology to crops in North America, the introduction of herbicide tolerance, and the introduction of insect resistance through the addition of Bt toxin genes.

The primary motivation for the development of herbicide-tolerant crops has been to secure market share for herbicide manufacturers, not to promote of more environmentally sustainable agriculture. This has been made clear in public statements by the firms that developed the technology. Furthermore, it has been argued that this application of biotechnology fails to recognize the causes of problems such as increased weed resistance to herbicides. These include inappropriate cropping patterns that promote weed populations. It is also argued that herbicide-resistant crops will entrench the dependence of agricultural production on external, capital, and energy-intensive chemical inputs, further narrow the genetic base employed for agricultural purposes, and increase farmers' dependence on specific agricultural supply firms. In the longer term, the selective pressure of more intensive herbicide use may lead to the emergence of even more resistant pests. A better approach might be to emphasize the development of alternatives to chemical pesticides for the control of agricultural pests.

The modification of crops for stress resistance may, under certain circumstances, have the potential to expand food production, but it may lead to serious problems as well. It was pointed out early in the development of genetically engineered crops that increased resistance to stress could lead to issues of invasiveness. Crops modified to produce Bt toxin demonstrate another problem related specifically to the introduction of resistance to pests.

It has been claimed that the introduction of pesticidal plants will reduce requirements for the use of chemical pesticides. Serious concerns, however,

have been raised that the widespread exposure of insects to high doses of Bt toxin will result in the rapid emergence of Bt-resistant pest populations. This will not only render the Bt crops themselves useless but may also result in the more general loss of Bt as an effective biological pest control agent. Such an outcome could hardly be described as being supportive of ecologically sustainable agriculture.

In general, the applications of agricultural biotechnology that have emerged to date have been closely integrated with conventional, capital-intensive agricultural practices employed in North America and Western Europe. Such practices are not a viable option for farmers in the developing world, who lack access to the capital necessary to employ them. Indeed, their introduction in the south has been associated with the displacement of smaller-scale producers supplying local food markets by large-scale producers growing largely for export to northern markets. Such trends do little to improve food security in the south. Additional concerns have been raised in the developing world regarding the economic impact of the use of agricultural biotechnology products in the north to replace commodities that have traditionally been grown in the south.

More broadly, the applications of biotechnology that have emerged in the agricultural field do little to address the fundamental questions of environmental sustainability which have been raised regarding conventional agricultural practices. Rather, they seem designed to reinforce and further entrench such practices. Conventional practices have been widely criticized as being inconsistent with the principles of sustainable development because they rely on increasing inputs of capital- and energy-intensive products such as pesticides, fertilizers, and mechanical equipment, to maintain productivity in the face of a declining ecological capital base of soil, genetic material, and water, and are themselves associated with major environmental externalities.

Despite the significance of such questions about the value and purpose of many of the applications of agricultural biotechnology, one of the central features of the Canadian and U.S. federal governments' approach to agricultural biotechnology products has been their refusal to address such issues. Rather, regulatory systems have been focused narrowly on the direct effects of the introduction of genetically engineered plants, microorganisms, and other products of modern biotechnology into the environment. Issues related to the long-term effects or desirability of the technology have been determined to be outside the scope of the regulatory system, and, indeed, apparently beyond the legitimate scope of public policy debate.

CONCLUSIONS

Agricultural applications of modern biotechnology, particularly genetic engineering, raise major ethical and social issues. North American governments are beginning to acknowledge the significance of these issues but have failed to

address them in any meaningful way. This is true despite the lack of evidence of any public consensus in favor of the adoption of these technologies and the chance that public discomfort is likely to grow as more products enter the marketplace.

The science regarding the ecological effects of agricultural biotechnology products remains under development, but recent findings seem to confirm many of the problems that were theorized in the past. This should be a signal for caution. Nevertheless, governments continue to grant approvals for commercialization and are making no provisions for monitoring environmental effects. Serious questions must be raised in particular about Bt crops and other pesticidal plants.

Finally, the emerging applications of biotechnology in the field of agriculture appear to have little or nothing to do with the establishment of more ecologically sustainable agriculture and food systems in North America or elsewhere in the world. In fact, many of the emerging applications seem likely to entrench environmentally unsustainable practices more deeply. Many of the emerging applications are simply irrelevant to global food concerns. They are being proposed as technological fixes to what are fundamentally social, economic, and political problems.

The development of agricultural biotechnology in North America has been supported by the expenditure of large sums of public funds. The public is therefore entitled to a voice in decisions about the acceptability of these technologies and the value of further public investments in them. In Western Europe, governments have been engaging the public in meaningful dialogues on the implications of biotechnology for their societies and appear to be prepared to act on the results. It is time for North American governments to do the same.